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ANDERSON ENGINEERING INC SPRINGFIELD MO

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NATIONAL DAM SAFETY PROGRAM. LAKE JA-HA DAM (MO 30251), MISSOUR--ETC(U)

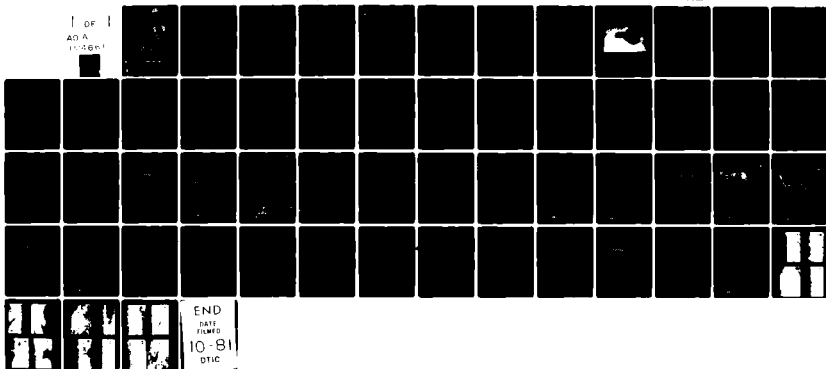
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MISSOURI-KANSAS CITY RIVER BASIN

AD A104661

**LAKE JA-HA DAM
MILLER COUNTY, MISSOURI
MO 30251**

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**PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM**



**United States Army
Corps of Engineers**
... Serving the Army
... Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

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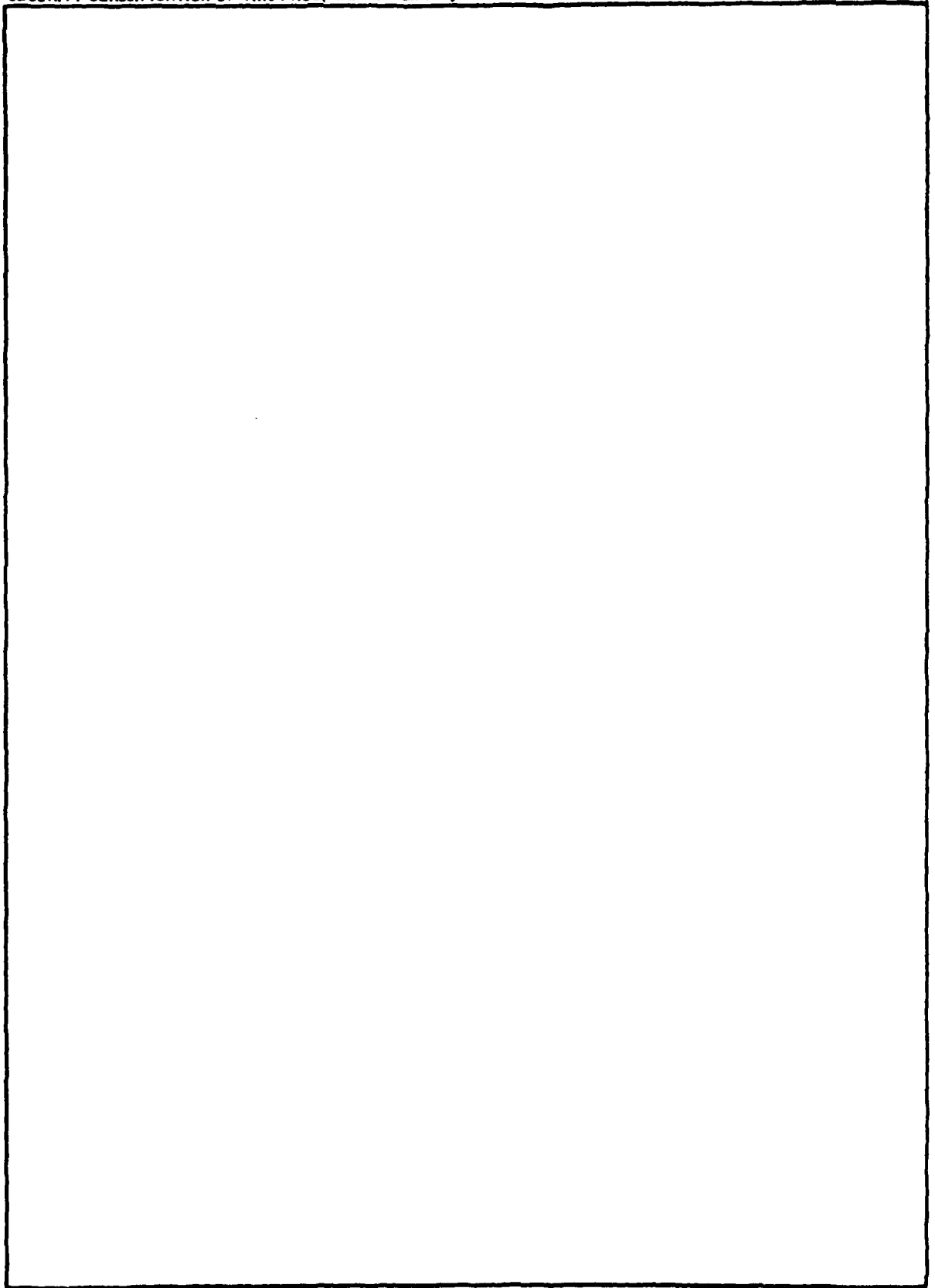
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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

ATTENTION OF

SUBJECT: Lake Ja-Ha Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lake Ja-Ha Dam (MO 30251).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.
- b. Overtopping of the dam could result in failure of the dam.
- c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED 8 SEP 1980
Chief, Engineering Division Date

APPROVED BY: SIGNED 8 SEP 1980
Colonel, CE, District Engineer Date

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MISSOURI-KANSAS CITY RIVER BASIN

LAKE JA-HA DAM

MILLER COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30251

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared By

Anderson Engineering, Inc., Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

Under Direction Of

St. Louis District, Corps of Engineers

For

Governor of Missouri

August 1980

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
SUMMARY

Name of Dam:	Lake Ja-Ha Dam
State Located:	Missouri
County Located:	Miller
Stream:	Unnamed Tributary of Blythes Creek
Date of Inspection:	April 28, 1980

Lake Ja-Ha Dam was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri, and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

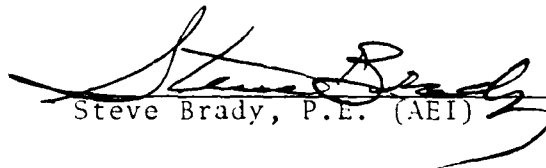
The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, the St. Louis District, Corps of Engineers has determined that this dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur if the dam fails. The estimated damage zone extends approximately 4 miles downstream of the dam. Located within this zone are a mobile home court (six homes), three dwellings, and three sheds. The existence of these structures was verified during the field inspection and at the time the aerial photographs were taken. The dam is in the small size classification, since maximum storage capacity is greater than 50 acre-ft but less than 1,000 acre-ft.

Our inspection and evaluation indicate that the spillway does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will pass 37 percent of the Probable Maximum Flood (PMF) without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of small size with a high downstream hazard potential pass 50 to 100 percent of the PMF. Considering the small size of the dam, the low reservoir storage capacity, and the wide floodplain downstream, 50 percent of the PMF has been determined to be the appropriate spillway design flood. The 1 percent probability

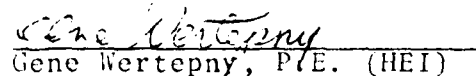
flood will not overtop the dam. The 1 percent probability flood is one that has a 1 percent chance of being exceeded in any given year.


Deficiencies visually observed by the inspection team were: (1) heavy brush and tree growth on the downstream embankment face; (2) seepage areas along a major length of the embankment toe; (3) a seepage area on the downstream face at about Station 5+00; (4) some wave erosion on portions of the upstream embankment face; (5) lack of a non-erodible spillway control section; (6) nearness of the spillway outlet channel to the embankment toe; and (7) lack of wave protection for the upstream face. Another deficiency was the lack of seepage and stability analysis records.

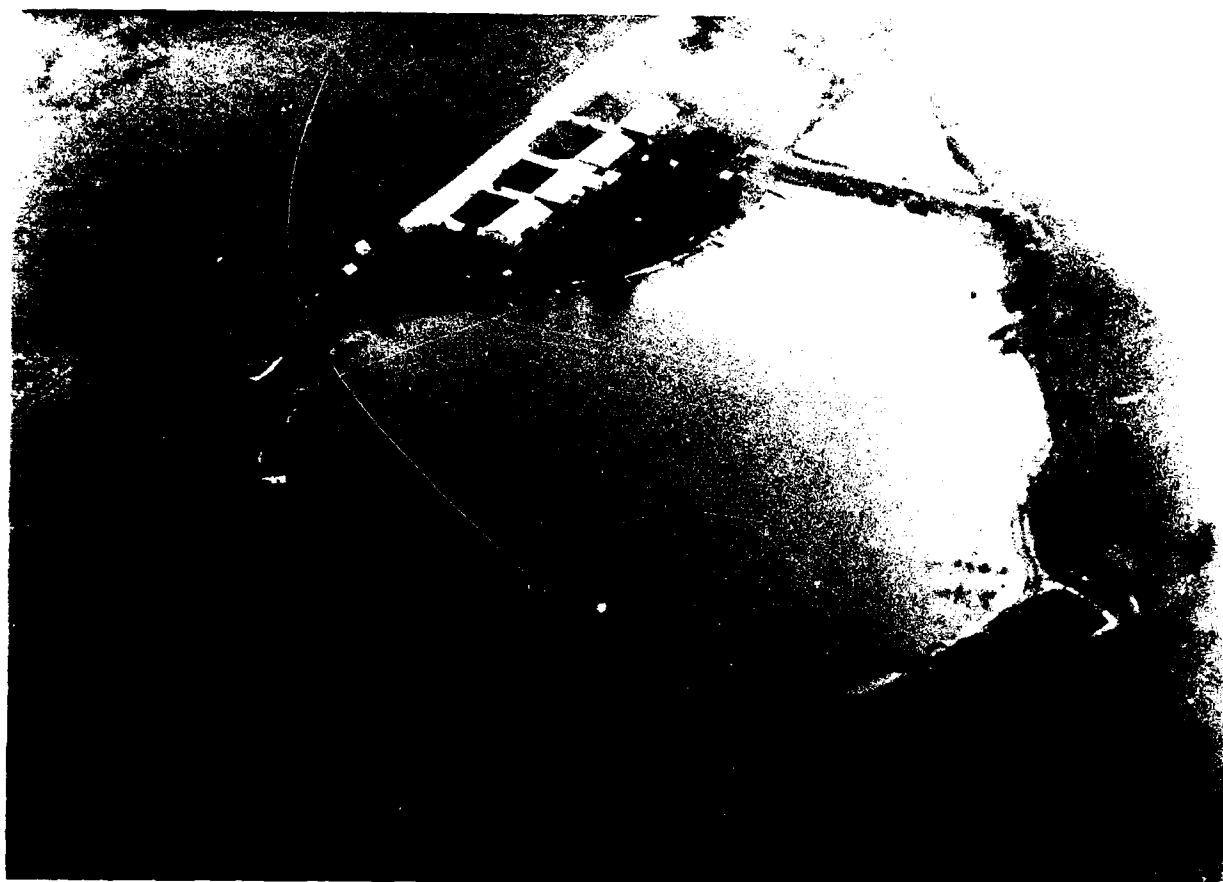
It is recommended that the owners take the necessary action promptly to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.


Steve Brady, P.E. (AEI)


Tom Beckley, P.E. (XEI)


Gene Wertepny, P.E. (HEI)


Dan Kerns, P.E. (HEI)



AERIAL VIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE JA-HA DAM - ID No. 30251

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of Lake Ja-Ha Dam in Miller County, Missouri.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

Lake Ja-Ha is an earth fill structure approximately 23 ft high and 1,140 ft long at the crest. In this report, right and left orientation is based on looking in the downstream direction. The appurtenant works consist of a trapezoidal earth cut spillway located at the left abutment. Sheet 3 of Appendix A shows a plan, profile, and typical section of the embankment. Presented on Sheet 4, Appendix A are profile and section views of the spillway.

B. Location:

The dam is located in the north-central part of Miller County, Missouri, on an unnamed tributary of Blythes Creek. The dam and lake are within the Eldon, Missouri, 7.5 minute quadrangle sheet (Section 34, T42N, R15W - latitude 38° 21.4' North; longitude 92° 33.5' West). Sheet 2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 23 ft and a maximum storage capacity of approximately 105 acre-ft, the dam is in the small size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a high hazard dam. The estimated damage zone extends approximately 4 miles downstream of the dam. Located within this zone are a mobile home court (six homes), three dwellings, and three sheds. The existence of these structures was verified during the field inspection and at the time the aerial photographs were taken.

E. Ownership:

The dam is owned by Mr. Alexander C. Olds. The owner's address is Route 1, Box 573, Eldon, Missouri 65026 (Telephone: 314-392-6954).

F. Purpose of Dam:

The dam was constructed primarily for recreation, with five homes on the north side of the lake.

G. Design and Construction History:

There is no design information available. Mr. Olds indicated that the dam was constructed in about 1965 by Admire and Small Construction, which is no longer in existence. The owner did not know if a key trench was incorporated into the dam. However, he reported that a sheepsfoot compactor was used during construction. The dam is apparently homogeneous. Material for construction of the dam was obtained from the lake area.

The only reported modification was the construction of the silting basin dam upstream of the lake in about 1975. Two 12 in. diameter corrugated metal pipes pass through the silting basin embankment.

H. Normal Operating Procedures:

The normal flows are discharged through an uncontrolled earth cut spillway located at the left abutment. Mr. Olds indicated that the dam had never been overtopped, and that the spillway had only operated once. This flood event occurred in 1978, when the depth of water over the spillway was about 8 in.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A presents a plan, profile, and typical section of the embankment. Sheet 4 of Appendix A shows a profile and section of the spillway.

A. Drainage Area:

The drainage area for this dam, as obtained from the U.S.G.S. quad sheet, is approximately 43 acres.

B. Discharge at Dam Site:

- (1) All discharge at the dam site is through an uncontrolled spillway.
- (2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - El. 894.0): 67 cfs
- (3) Estimated Capacity of Primary Spillway: 67 cfs
- (4) Estimated Experienced Maximum Flood at Dam Site: 12 cfs (Elev. 892.7 as reported by owner)
- (5) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable
- (6) Diversion Tunnel Outlet at Pool Elevation: Not Applicable
- (7) Gated Spillway Capacity at Pool Elevation: Not Applicable
- (8) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations:

All elevations are consistent with an assumed mean sea level (MSL) elevation of 892 for the spillway crest (estimated from quadrangle map).

- (1) Top of Dam: 894.0 (Low Point); 896.7 (High Point)
- (2) Principal Spillway Crest: 892.0
- (3) Emergency Spillway Crest: None
- (4) Principal Outlet Pipe Invert: None
- (5) Streambed at Centerline of Dam: 871.1

- (6) Pool on Date of Inspection: 891.5
- (7) Apparent High Water Mark: None Apparent
- (8) Maximum Tailwater: Unknown
- (9) Upstream Portal Invert Diversion Tunnel: Not Applicable
- (10) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

- (1) At Top of Dam: 1,020 ft
- (2) At Principal Spillway Crest: 1,000 ft
- (3) At Emergency Spillway Crest: Not Applicable

E. Storage Capacities:

- (1) At Principal Spillway Crest: 82 acre-ft
- (2) At Top of Dam: 105 acre-ft
- (3) At Emergency Spillway Crest: Not Applicable

F. Reservoir Surface Areas:

- (1) At Principal Spillway Crest: 10.5 acres
- (2) At Top of Dam: 11.8 acres
- (3) At Emergency Spillway Crest: Not Applicable

G. Dam:

- (1) Type: Earth
- (2) Length at Crest: 1,140 ft
- (3) Height: 23 ft
- (4) Top Width: 10 ft
- (5) Side Slopes: Upstream 3.0H:1.0V (to water's edge);
Downstream varies from 2.2H:1.0V to 2.9H:1.0V (see
Sheet 3, Appendix A)
- (6) Zoning: Apparently Homogeneous

(7) Impervious Core: None

(8) Cutoff: Unknown

(9) Grout Curtain: None

H. Diversion and Regulating Tunnel:

(1) Type: Not Applicable

(2) Length: Not Applicable

(3) Closure: Not Applicable

(4) Access: Not Applicable

(5) Regulating Facilities: Not Applicable

I. Spillway:

I.1 Principal Spillway:

(1) Location: Left Abutment

(2) Type: Earth Cut

I.2 Emergency Spillway:

(1) Location: Not Applicable

(2) Type: Not Applicable

J. Regulating Outlets:

There are no regulating outlets associated with Lake Ja-Ha Dam.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

No engineering data exist for this dam. To our knowledge, no construction inspection records or documented maintenance and operation data exist.

A. Surveys:

No information regarding pre-construction surveys was able to be obtained. Sheet 3 of Appendix A presents a plan, profile, and cross section of the dam from survey data obtained during the site inspection. The crest of the spillway (reservoir normal pool) was used as a reference point to determine all other elevations. It is estimated that this site datum approximately corresponds to mean sea level (MSL) elevation 892.

B. Geology and Subsurface Materials:

The site is located in the north-central portion of the Ozarks geologic region of Missouri. The Ozarks are characterized topographically by hills, plateaus, and deep valleys. The most common bedrock types are dolomite, sandstone, and chert. The "Geologic Map of Missouri" indicates that the bedrock in the site area consists primarily of the Jefferson City and Roubidoux formations of the Canadian Series of the Ordovician System. The Roubidoux formation in central Missouri is predominantly a quartzose sandstone composed of fine to medium-grained quartz sand. The thickness of the Roubidoux ranges from 100 ft to 250 ft. The Jefferson City formation is composed principally of light brown to brown, medium to finely crystalline dolomite and argillaceous dolomite. The average thickness of the Jefferson City is 200 ft.

The publication "Caves of Missouri" indicates that Miller County has 18 named and located caves, all located south and southeast of the project site. The closest listed cave is located about 8 miles south of the site, and eight caves (including three caves in adjacent Cole County) are clustered in an area about 17 miles southeast of the site.

The "Geologic Map of Missouri" indicates a normal fault passing about 3 miles south of the site in a north-west-southeast direction. The Missouri Geological Survey has indicated that the faults in this area are generally considered to be inactive and have been for several hundred million years.

The Soil Conservation Service has indicated that the soils in the area of the dam are the Creldon Series, consisting of deep, moderately well drained soils formed in loess over cherty residuum. Eldon and Captina soils are likely to be present in the watershed area. The thickness of loessial deposits in upland areas may range from 2.5 ft to 5.0 ft.

C. Foundation and Embankment Design:

No foundation and embankment design information was available. Seepage and stability analyses apparently were not performed as required in the guidelines. There is apparently no particular zoning of the embankment, and no internal drainage features are known to exist. No construction inspection test results have been obtained.

D. Hydrology and Hydraulics:

No hydrologic or hydraulic design computations for this dam were available. Based on a field check of spillway dimensions and embankment elevations, and a check of the drainage area on U.S.G.S. quad sheets, hydrologic analyses using U.S. Army Corps of Engineers guidelines were performed and appear in Appendix C, Sheets 1 to 9.

E. Structure:

There are no structures associated with Lake Ja-Ha Dam.

2.2 CONSTRUCTION:

No construction inspection data were available.

2.3 OPERATION:

Normal flows are passed by an uncontrolled earth cut spillway located in the left abutment. No operating facilities exist.

2.4 EVALUATION:

A. Availability:

No engineering data, seepage or stability analyses, or construction test data were available.

B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction, and

operation of this structure. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

C. Validity:

To our knowledge, no valid engineering data on the design or construction of the embankment are available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS:

A. General:

The field inspection was made on April 28, 1980. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri, and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Steve Brady - Anderson Engineering, Inc. (Civil Engineer)
Tom Beckley - Anderson Engineering, Inc. (Civil Engineer)
Gene Wertepny - Hanson Engineers, Inc. (Hydraulic Engineer)
Dan Kerns - Hanson Engineers, Inc. (Geotechnical Engineer)

Photographs of the dam, appurtenant structures, reservoir, and downstream features are presented in Appendix D.

B. Dam:

The dam appears to be in generally good condition. The downstream embankment face is heavily overgrown with brush and trees. A small seepage area was noted on the embankment face at about Station 5+00. This area was located about mid-way between the crest and toe and was soft and wet. No obvious flows were observed, and it did not appear that soil particles had been transported from this area. In addition, seepage was observed along a major portion of the embankment toe (see Sheet 4, Appendix A).

The horizontal and vertical alignments of the crest appeared good, and no surface cracking or unusual movement was obvious. No wave protection is provided for the upstream embankment face, and some wave erosion was noted. Shallow auger probes into the embankment indicated the dam to consist of a brown very fine sandy clayey silt. Information from the owner indicates that material for construction of the dam was obtained from the lake area.

A small sewage lagoon, serving the five homes on the shore of the lake, is located just beyond the embankment toe near the right abutment (see Photo 16). The embankment in this area is only a few feet high. Sheet 5 of Appendix A presents a plan sketch of the dam showing observed features.

C. Appurtenant Structures:

C.1 Primary Spillway:

The approach area to the spillway was clear. No non-erodible control section exists for the spillway. The spillway outlet passes along the toe of the embankment to the

downstream channel. The outlet channel is only discernible for a few hundred feet past the spillway crest; beyond, the outlet channel is very shallow and is grass-covered. No significant erosion was noted in the outlet area.

C.2 Emergency Spillway:

There is no emergency spillway associated with Lake Ja-Ha Dam.

D. Reservoir:

The watershed is generally pastureland with little or no agricultural activity. Five homes have been built along the north side of the lake. The slopes adjacent to the reservoir are moderate, and no sloughing or serious erosion was noted. No evidence of major siltation of the reservoir was noted. The recently built silting pond will significantly reduce siltation of the reservoir.

E. Downstream Channel:

The downstream channel is wide and fairly clear for a few hundred feet past the toe. Beyond a few hundred feet, the channel enters a wooded area (see Photo 11).

3.2 EVALUATION:

The tree and brush growth on the downstream embankment face can provide shelter for small animals and encourage burrowing. The seepage from the dam and along the embankment toe could adversely affect the stability of the dam. The wave erosion on the upstream face could worsen and adversely affect embankment stability. Due to the lack of a non-erodible spillway control section, sustained flows could erode the spillway and effectively lower the normal pool of the lake. Spillway discharges down the embankment-dam contact could cause erosion and undercut the toe. These deficiencies should be corrected under the direction of an engineer experienced in the design and construction of dams.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

There are no operating facilities associated with this dam. The pool is normally controlled by rainfall, runoff, evaporation, the capacity of the uncontrolled spillway, and seepage from the reservoir.

4.2 MAINTENANCE OF DAM:

The presence of brush and tree growth indicates that the dam has not been properly maintained recently.

4.3 MAINTENANCE OF OPERATING FACILITIES:

There are no operating facilities for this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

The brush and tree growth on the downstream face, seepage from the dam and along the embankment toe, nearness of the spillway discharge channel at the embankment toe, wave erosion of the upstream face, and lack of a non-erodible spillway control section are serious deficiencies which should be corrected. However, to avoid creating an unsafe condition, these deficiencies should only be corrected under the direction of an engineer experienced in the design and construction of dams.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. Design Data:

No hydrologic or hydraulic design computations for this dam were available.

B. Experience Data:

No recorded rainfall, runoff, discharge, or reservoir stage data were available for this lake and watershed. The owner reported that the spillway had operated only once, in 1978, when the maximum depth of water over the spillway crest was about 8 in.

C. Visual Observations:

The approach area to the spillway was clear. No non-erodible control section exists for the spillway. The spillway outlet passes along the toe of the embankment to the downstream channel. The outlet channel is only discernible for a few hundred feet past the spillway crest; beyond, the outlet channel is very shallow and is grass-covered. No significant erosion was noted in the outlet area.

D. Overtopping Potential:

The hydraulic and hydrologic analyses (using the U.S. Army Corps of Engineers guidelines and the HEC-1 computer program) were based on: (1) a field survey of spillway dimensions and embankment elevations; and (2) an estimate of the reservoir storage and the pool and drainage areas from the Eldon, Missouri, 7.5 Minute USGS quad sheet. The effects of the silting basin were taken into account in the hydraulic and hydrologic analyses.

Based on the hydrologic and hydraulic analyses presented in Appendix C, the spillway will pass 37 percent of the Probable Maximum Flood. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that this structure (small size with high downstream hazard potential) pass 50 percent to 100 percent of the PMF, without overtopping. Considering the small size of the dam, the low storage capacity of the reservoir and the wide floodplain downstream, 50 percent of the PMF has been determined to be the appropriate spillway design flood. The spillway will pass the 1 percent probability flood without overtopping the dam.

Application of the Probable Maximum Precipitation (PMP), minus losses, resulted in a flood hydrograph peak inflow of 1,260 cfs. For 50 percent of the PMP, the peak inflow was 630 cfs.

The routing of the PMF through the spillway and dam indicates that the dam will be overtopped by 0.9 ft at elevation 894.9. The duration of the overtopping will be 5.8 hours, and the maximum outflow will be 948 cfs. The maximum discharge capacity of the spillway is 67 cfs. The routing of 50 percent of the PMF indicates that the dam will be overtopped by 0.4 ft at elevation 894.4. The maximum outflow will be 208 cfs, and the duration of overtopping will be 3.0 hours. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure. Considering the type of materials which comprise the dam and the height and duration of overtopping, significant damage or failure of the dam would be expected if the design flood occurs.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Observed features which could adversely affect the structural stability of this dam are discussed in Sections 3.1B and 3.2.

B. Design and Construction Data:

No design or construction data were available for this dam. Seepage and stability analyses comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

C. Operating Records:

There are no operating facilities for this dam.

D. Post-Construction Changes:

The only reported post-construction change was the addition in 1975 of the silting basin dam upstream of Lake Ja-Ha.

E Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in stability analyses performed for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

A. Safety:

The embankment is generally in good condition. Several items were noted during the visual inspection which should be investigated further, corrected or controlled. These items are: (1) heavy brush and tree growth on the downstream embankment face; (2) seepage areas along a major length of the embankment toe; (3) a seepage area on the downstream face at about Station 5+00; (4) some wave erosion on portions of the upstream embankment face; (5) lack of a non-erodible spillway control section; (6) nearness of the spillway outlet channel to the embankment toe; and (7) lack of wave protection for the upstream face. Another deficiency was the lack of seepage and stability analysis records.

The dam will be overtopped by flows in excess of 37 percent of the Probable Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

B. Adequacy of Information:

The conclusions in this report were based on the performance history as related by others, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

C. Urgency:

The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If the deficiencies listed in paragraph A are not corrected, and if good

maintenance is not provided, the embankment condition will continue to deteriorate and possibly could become serious in the future. The item recommended in paragraph 7.2A should be pursued promptly.

D. Necessity for Additional Inspection:

Based on the result of the Phase I inspection, no additional inspection is recommended.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

A. Alternatives:

- (1) Spillway size and/or height of dam should be increased to pass 50 percent of the PMF. In either case, the spillway should be protected to prevent erosion.

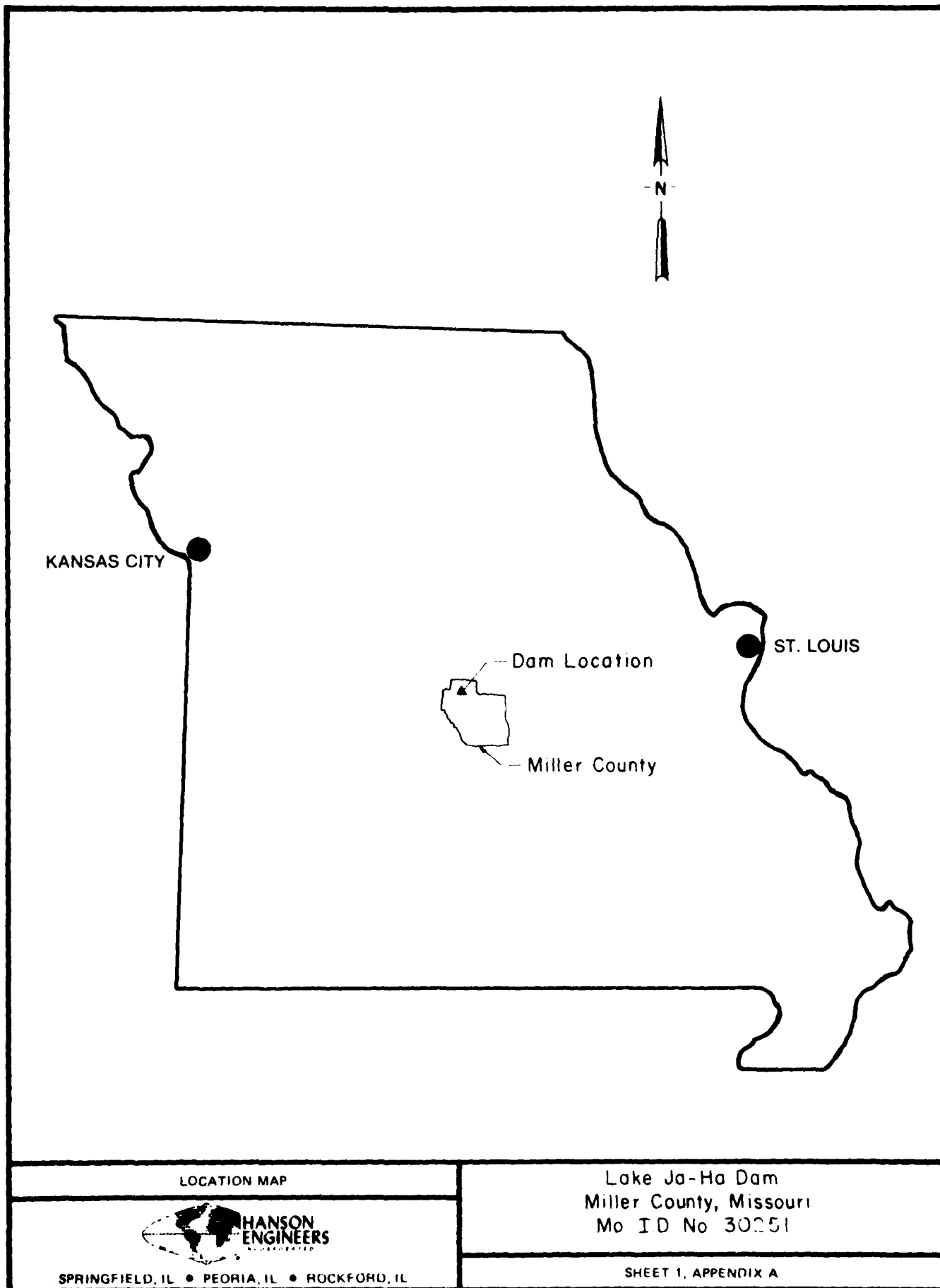
B. O&M Procedures:

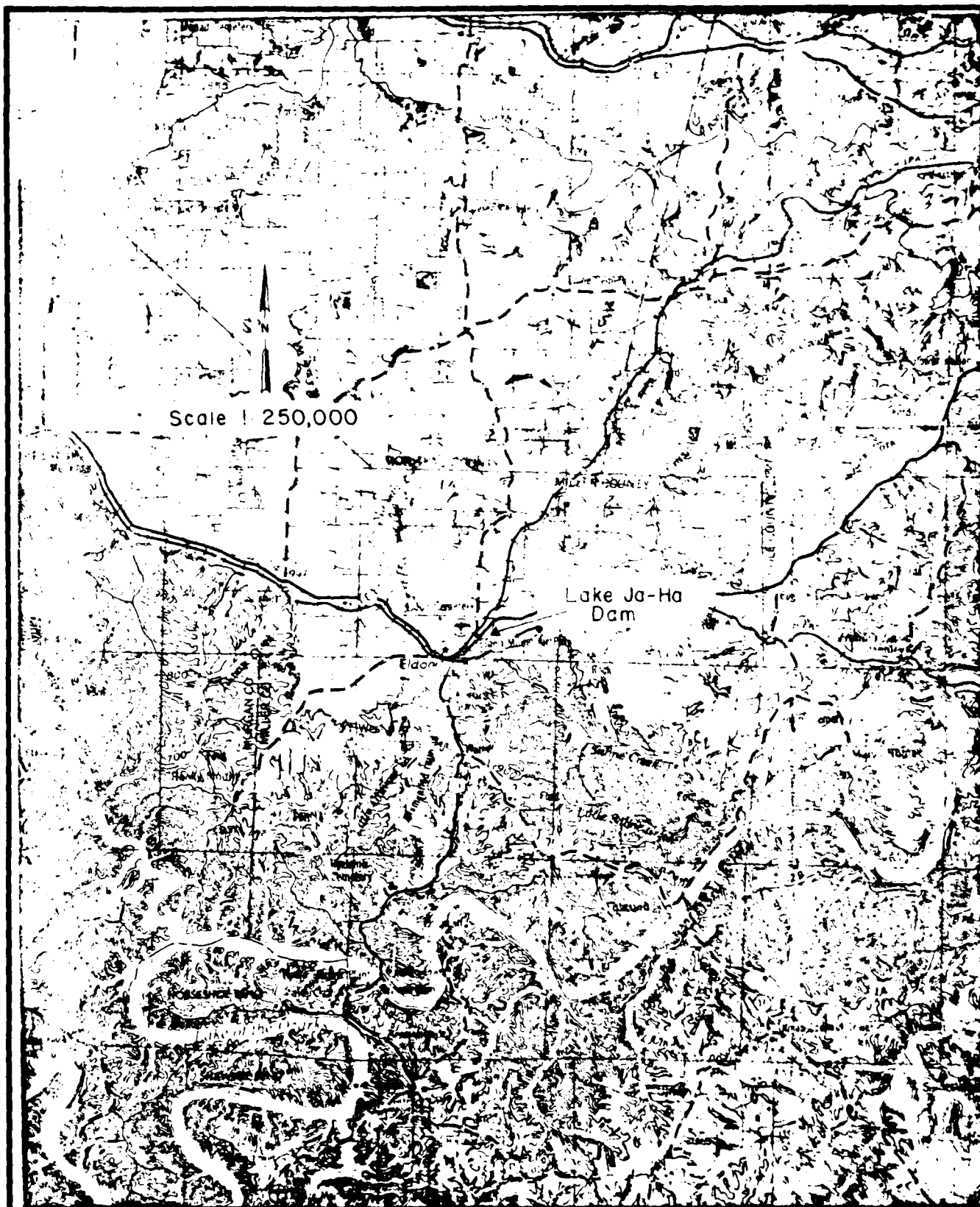
- (1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the construction of dams.
- (2) Trees and brush should be removed from the face of the dam on an annual basis. The initial clearing should be done under the guidance of a professional engineer experienced in the design and construction of dams. Indiscriminate clearing methods could jeopardize the safety of the dam.

- (3) The seepage areas noted on the downstream face and along the embankment toe should be investigated by an engineer experienced in the design and construction of dams. Remedial measures may be required. As a minimum, these areas should be inspected periodically in an effort to detect an increase in the quantity of seepage or any indication that soil particles are being carried by the water. In this event, an experienced engineer should be contacted immediately.
- (4) A non-erodible spillway control section should be provided so that progressive erosion of the spillway will not lower the normal pool of the reservoir.
- (5) Wave protection should be provided for the upstream face of the dam.
- (6) The spillway outlet channel should be directed well away from the embankment-abutment contact.
- (7) A detailed inspection of the dam should be made periodically by an engineer experienced in the design and construction of dams.

APPENDIX A

Dam Location and Plans





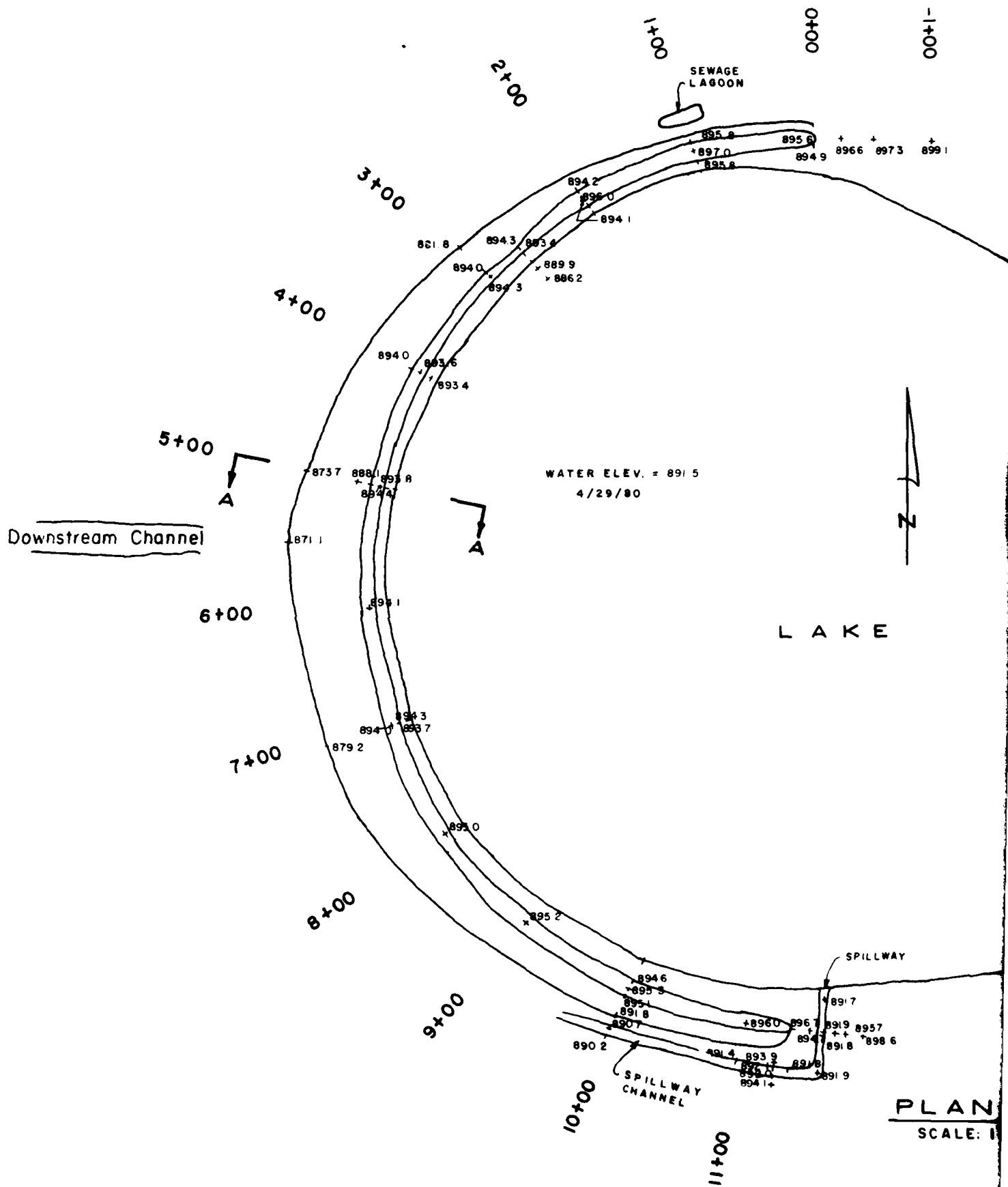
VICINITY MAP



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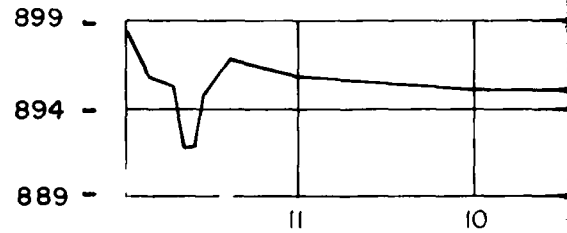
Lake Ja-Ha Dam
Miller County, Missouri
Mo ID No 30251

Sheet 2, Appendix A

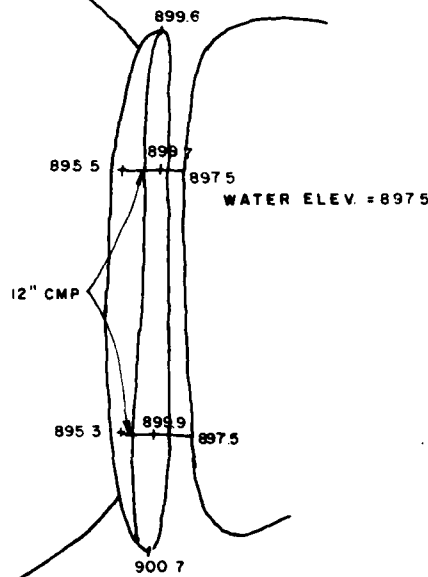


00+1-

897.3 899.1



E



WATER ELEV.
891.5

3.0

10'

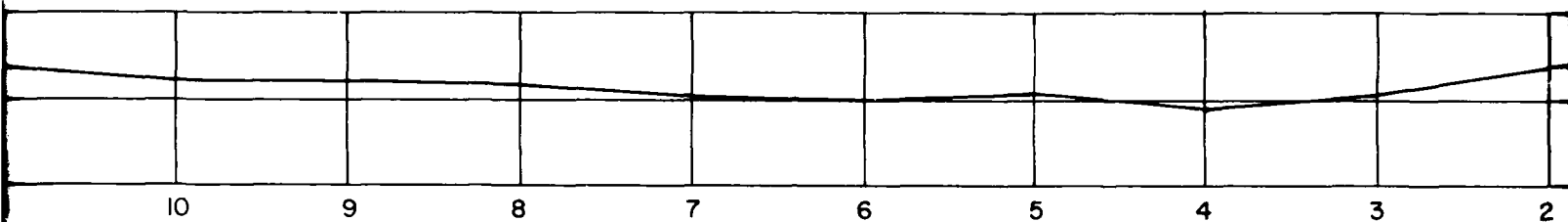
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0

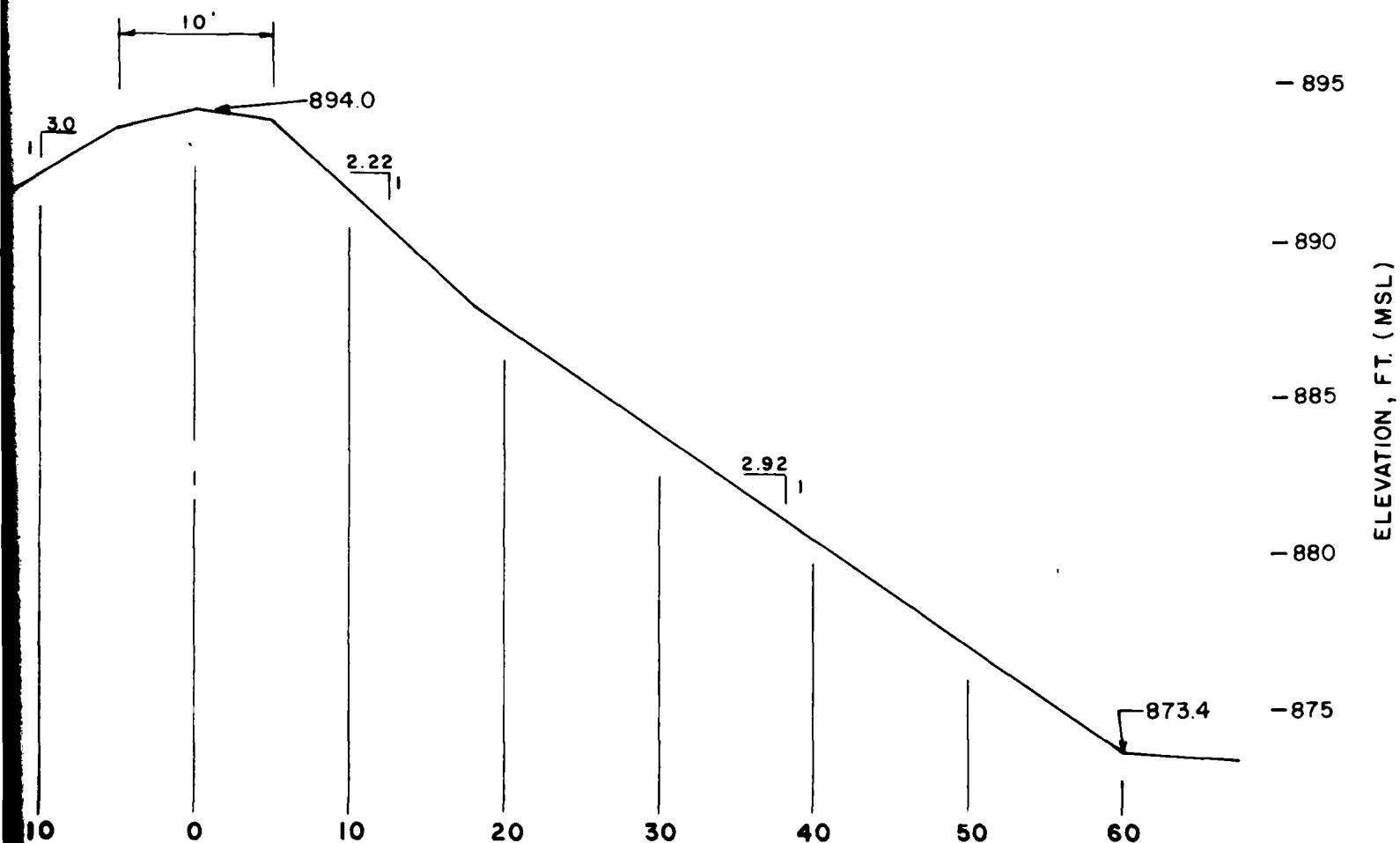
PLAN VIEW

SCALE: 1"=100'

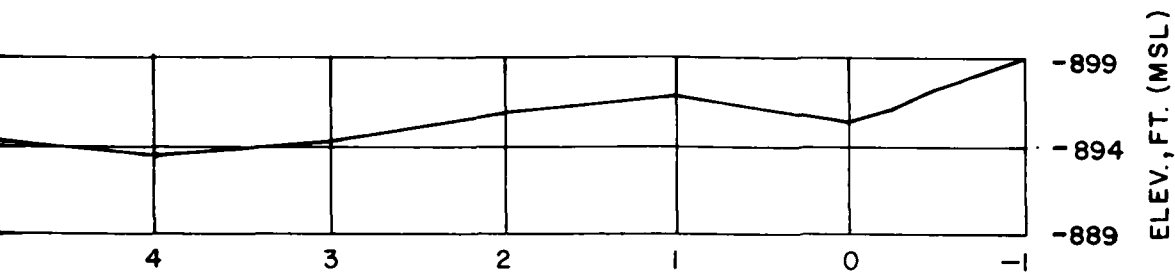
12



PROFILE



SECTION A-A STA 5+00



- 895

- 890

- 885

- 880

ELEVATION, FT. (MSL)

- 875

873.4

60

SHEET 3 APPENDIX A

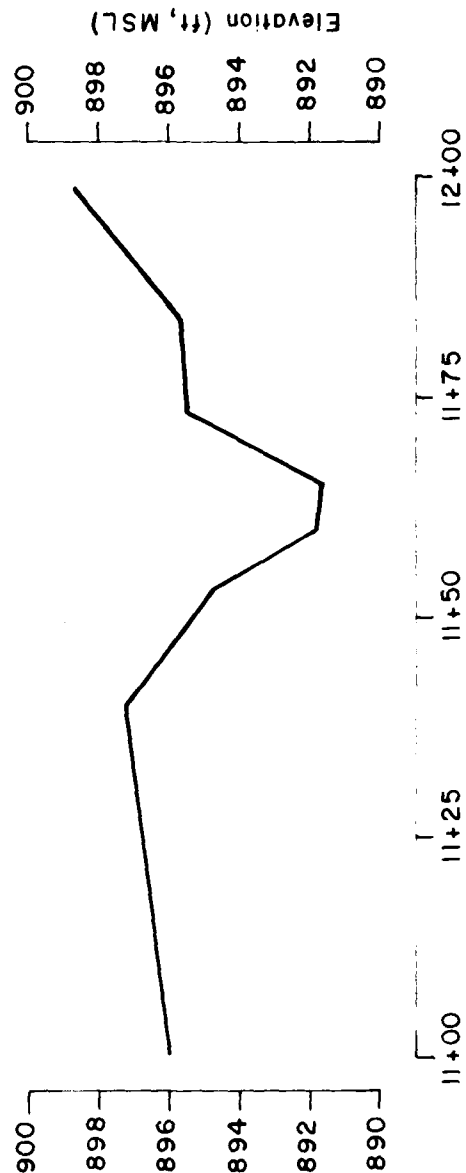
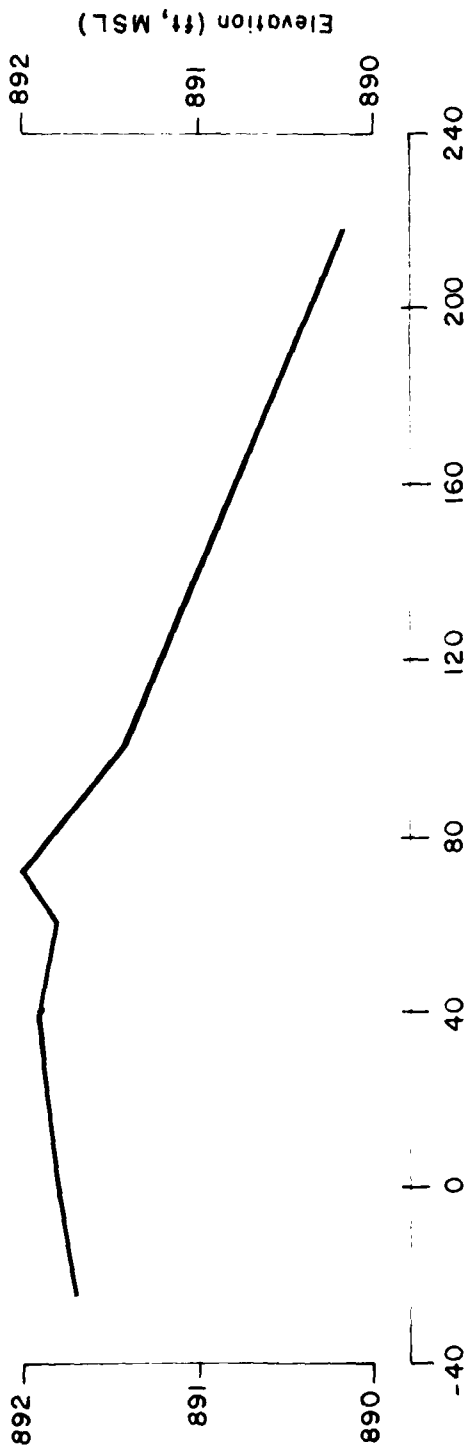
ANDERSON ENGINEERING, INC.
730 NORTH BENTON AVENUE
SPRINGFIELD, MISSOURI 65802

LAKE JA-HA

MO. No. 30251

PLAN & PROFILE

MILLER COUNTY, MO.



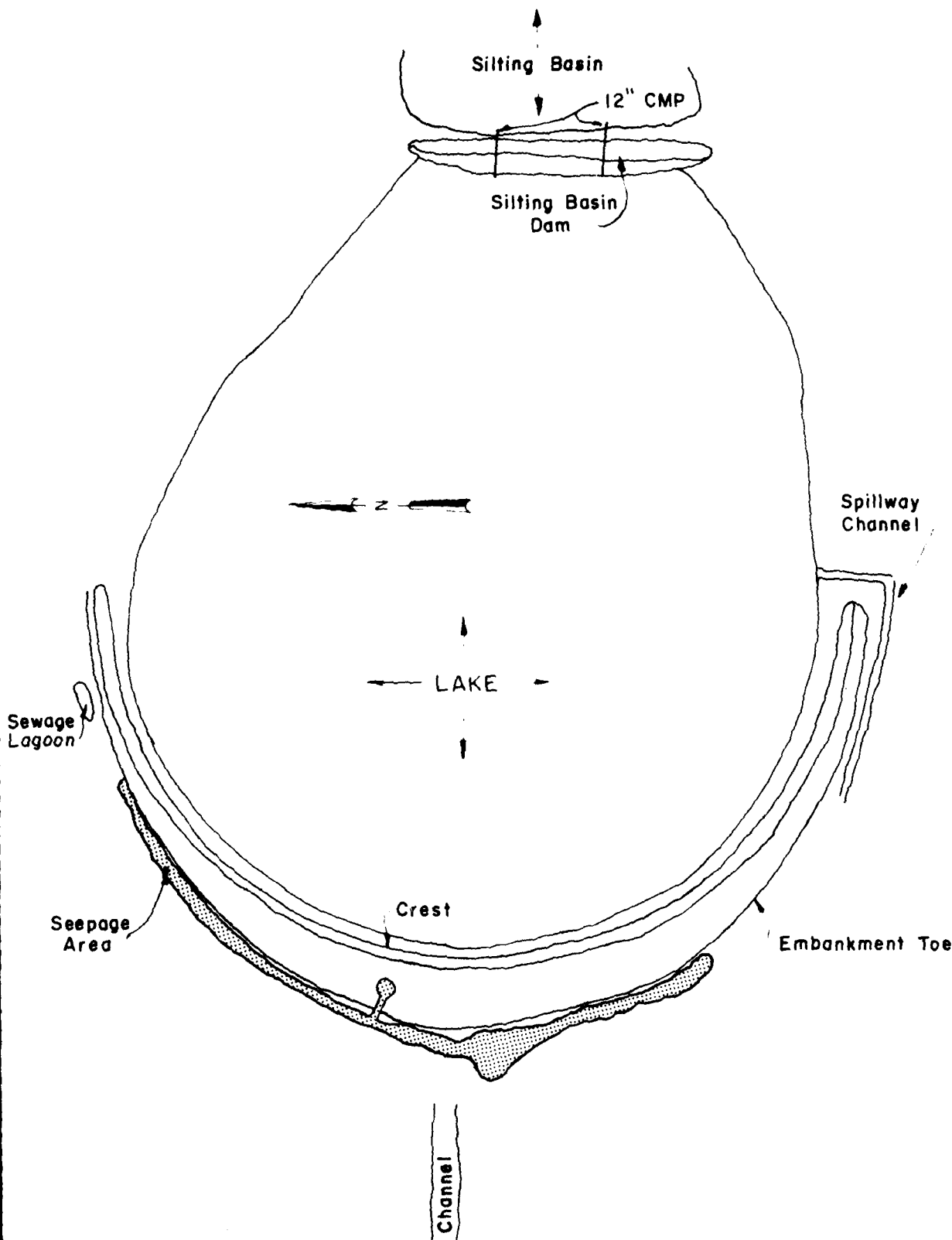
Profile and Section of Spillway



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Lake Ja-Ha Dam
Miller County, Missouri
Mo. ID. No. 30251

Sheet 4, Appendix A



Plan Sketch of Dam



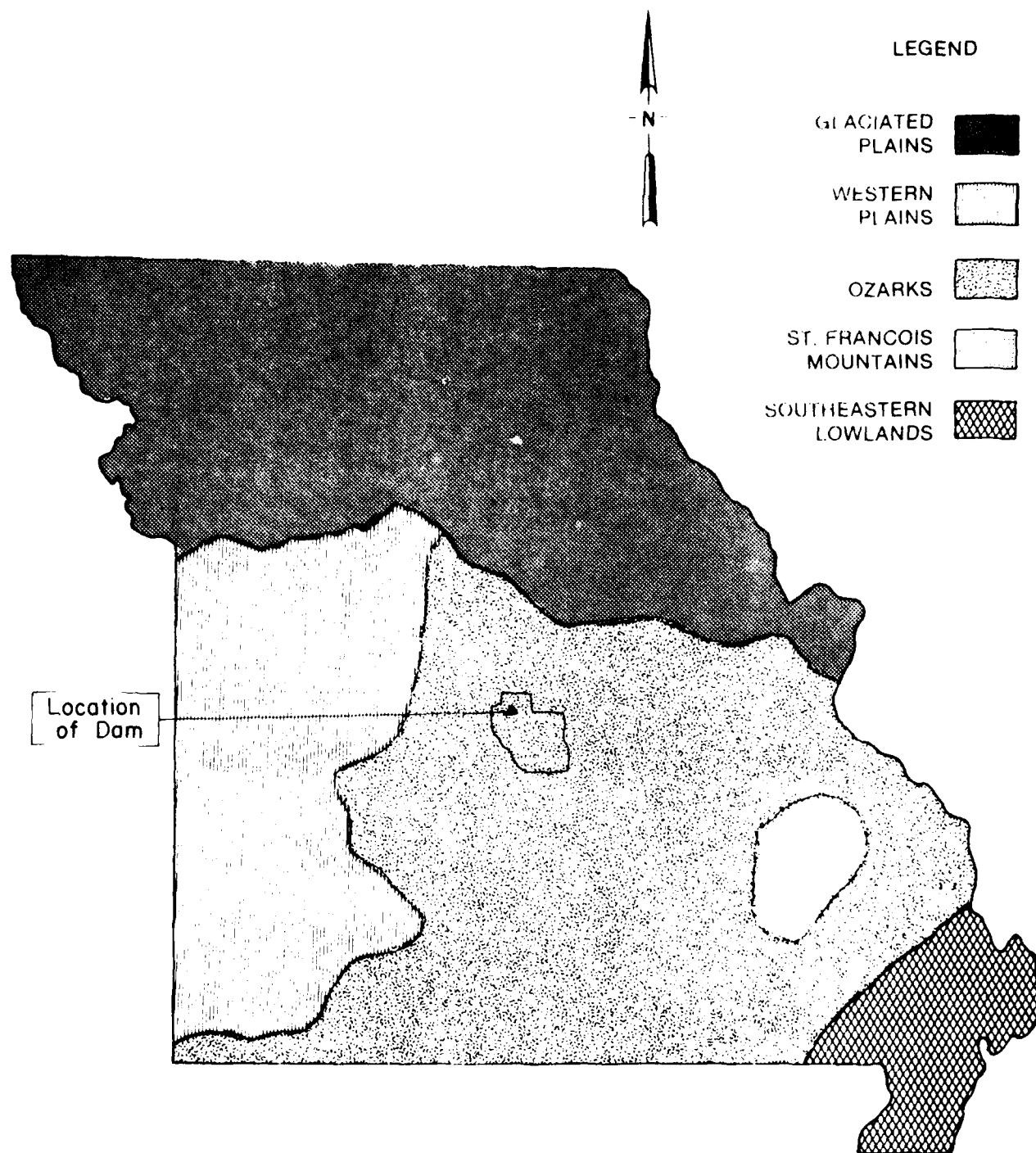
SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Lake Ja-Ha Dam
Miller County, Missouri
Mo. I.D. No 30251

Sheet 5, Appendix A

APPENDIX B

Geology and Soils



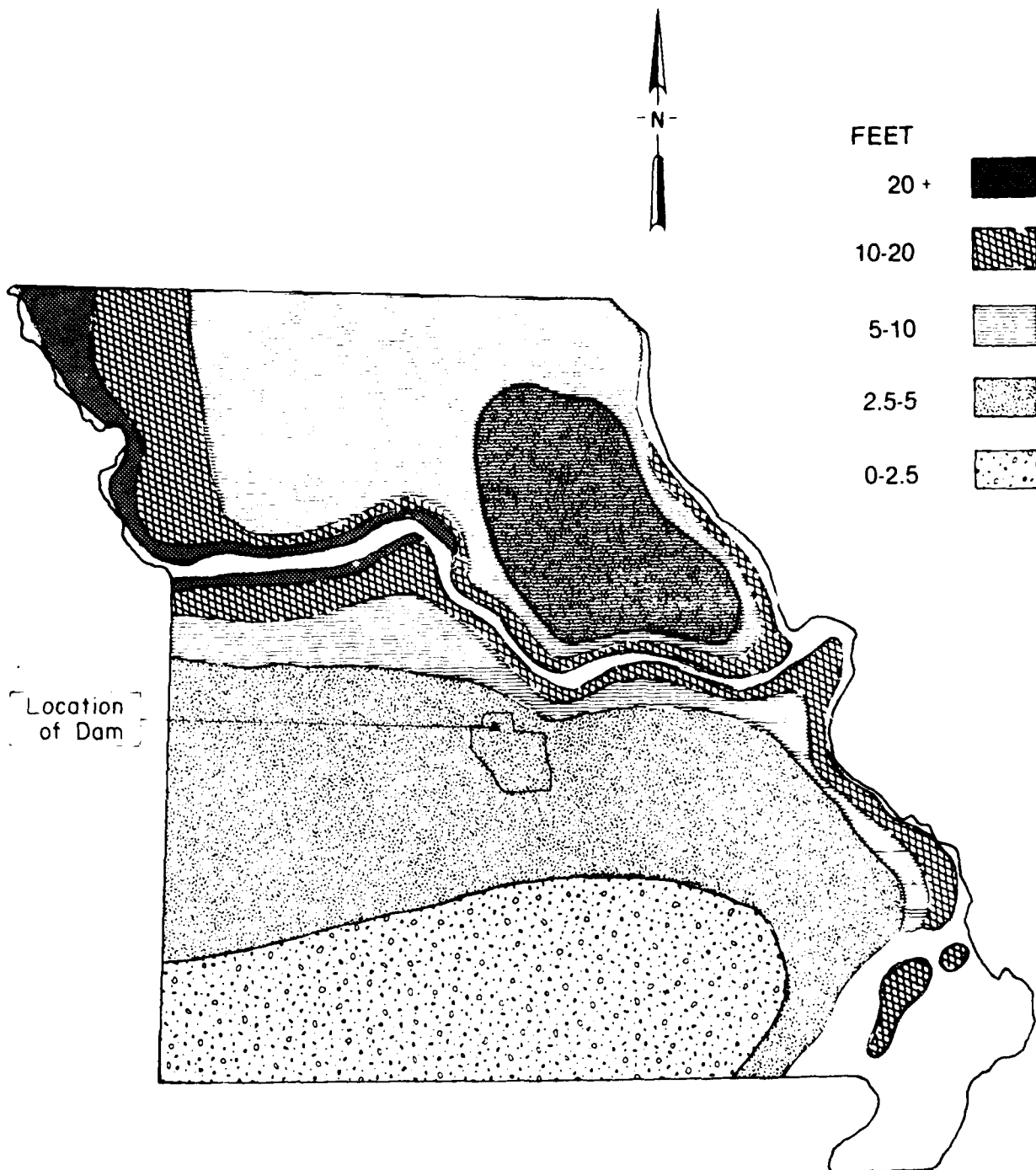
MAJOR GEOLOGIC REGIONS OF MISSOURI



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Lake Ja-Ha Dam
Miller County, Missouri
Mo. ID No. 30251

SHEET 1 APPENDIX B



THICKNESS OF LOESSIAL DEPOSITS



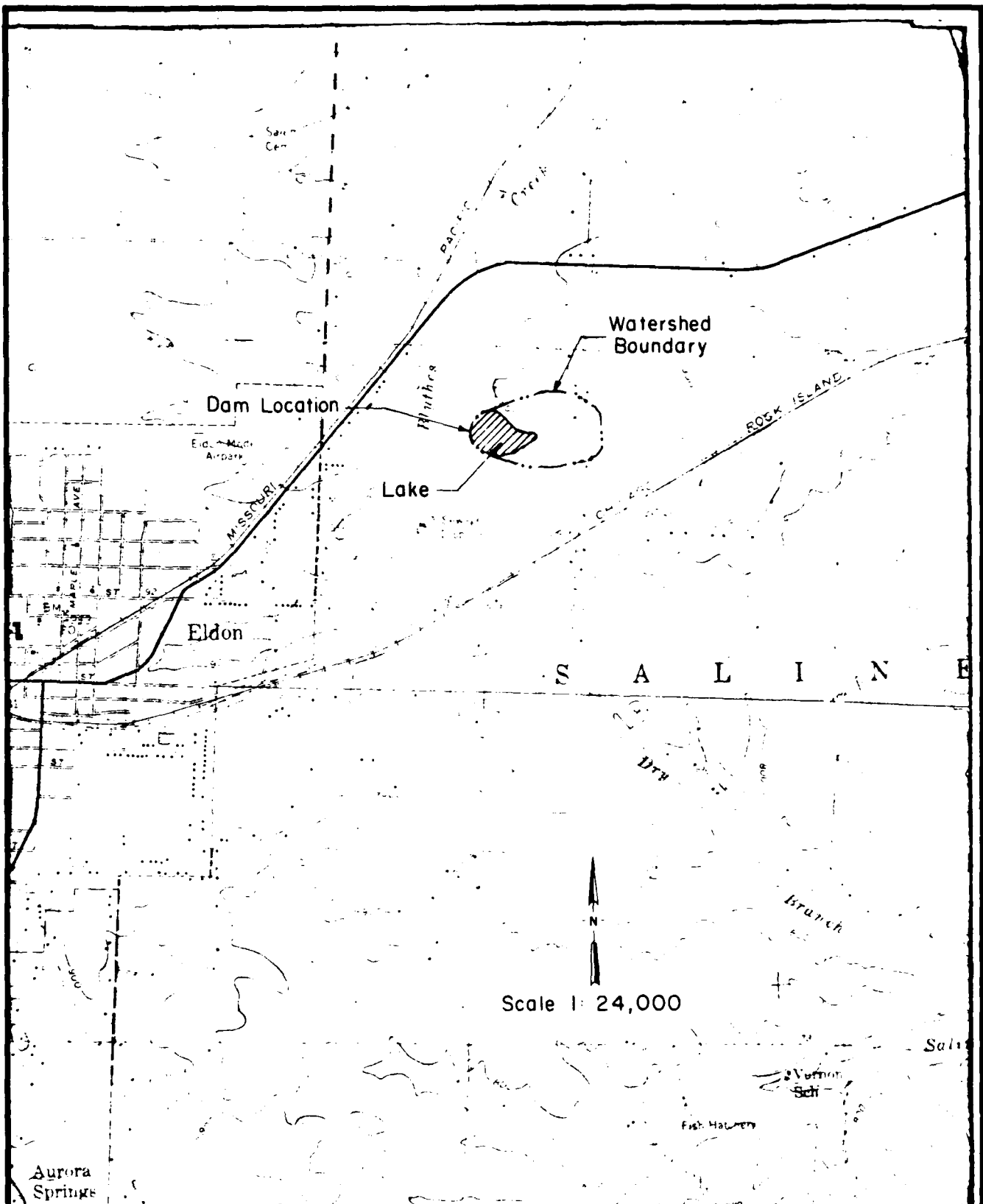
SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Lake Ja-Ha Dam
Miller County, Missouri
Mo ID No 30251

SHEET 2, APPENDIX B

APPENDIX C

Overtopping Analysis



LAKE AND WATERSHED MAP



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Lake Ja-Ha Dam
Miller County, Missouri
Mo. I.D. No. 30251

Sheet I, Appendix C

APPENDIX C

HYDROLOGIC AND HYDRAULIC ANALYSIS

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to a synthetic unit hydrograph to develop the inflow hydrograph. The inflow hydrograph was then routed through the reservoir and spillway. The overtopping analysis was accomplished using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm duration was assumed according to the procedures outlined in EM 1110-2-1411 (SPD Determination). Also, the 1 percent chance probability flood was routed through the reservoir and spillway. Jefferson City rainfall distribution, (5 min. interval - 24 hours duration) as provided by the St. Louis District, Corps of Engineers, was used in this case.

The synthetic unit hydrograph for the watershed was developed by the computer program using the SCS method. The parameters for the unit hydrograph are shown in Table 1 (Sheet 3, Appendix C).

The SCS curve number (CN) method was used in computing the infiltration losses for rainfall-runoff relationship. The CN values used, and the result from the computer output, are shown in Table 2 (Sheet 4, Appendix C).

The reservoir routing was accomplished by using the Modified Puls Method. The hydraulic capacity of the spillway was used as an outlet control in the routing. The hydraulic capacity of the spillway and the storage capacity of the reservoir were defined by the elevation-surface area--storage-discharge relationships shown in Table 3 (Sheet 4, Appendix C).

The rating curve for the spillway (see Table 4 Sheet 5, Appendix C) was determined assuming critical flow over a broad-crested weir.

The flow over the crest of the dam during overtopping was determined using the non-level dam option (\$L and \$V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir.

A summary of the routing analysis for different ratios of the PMF is shown in Table 5 (Sheet 6, Appendix C).

The computer input data, a summary of the output data, and a plot of the inflow-outflow hydrograph for the PMF are presented on Sheets 7, 8 and 9 of Appendix C.

TABLE 1
SYNTHETIC UNIT HYDROGRAPH

Parameters:

Drainage Area (A)	0.07 sq. miles
Length of Watercourse (L)	0.20 miles
Difference in elevation (H)	53 feet
Time of concentration (Tc)	0.09 hours
Lag Time (Lg)	0.05 hours
Time to peak (Tp)	0.09 hours
Peak Discharge (Qp)	376 cfs
Duration (D)	5 min.

<u>Time (Min.)(*)</u>	<u>Discharge (cfs)(*)</u>
0	0
5	362
10	139
15	32
20	7
25	2
30	0

(*) From the computer output

FORMULA USED:

$$T_c = \left(\frac{11.9 L^3}{H} \right)^{0.385}$$

$$L_g = 0.6 T_c$$

$$T_p = \frac{D}{2} + L_g$$

$$Q_p = \frac{484 A \cdot Q}{T_p} \quad Q = \text{Excess Runoff} = 1 \text{ inch}$$

TABLE 2
RAINFALL-RUNOFF VALUES

<u>Selected Storm Event</u>	<u>Storm Duration (Hours)</u>	<u>Rainfall (Inches)</u>	<u>Runoff (Inches)</u>	<u>Loss (Inches)</u>
PMP	24	33.15	32.30	0.85
1% Prob. Flood	24	7.45	5.74	1.71

Additional Data:

- 1) Soil Conservation Service Soil Group D
- 2) Soil Conservation Service Runoff Curve CN = 91 (AMC III) for the PMF
- 3) Soil Conservation Service Runoff Curve CN = 80 (AMC II) for the 1 percent chance flood
- 4) Percentage of Drainage Basin Impervious 27 percent

TABLE 3
ELEVATION, SURFACE AREA, STORAGE AND DISCHARGE RELATIONSHIPS

<u>Elevation (feet-MSL)</u>	<u>Lake Surface Area (acres)</u>	<u>Lake Storage (acre-ft)</u>	<u>Spillway Discharge (cfs)</u>
871.0	0	0	-
880.0	1.8	8	-
*892.0	10.5	82	0
**894.0	11.8	105	67
896.0	13.0	130	274
900.0	15.6	187	-

*Primary spillway crest elevation

**Top of dam elevation

TABLE 4
SPILLWAYS RATING CURVE

<u>Reservoir Elevation</u> (ft, MSL)	<u>Spillway Discharge</u> (cfs)
892.0	0
893.0	20
*894.0	67
895.0	141
896.0	274
897.0	482

*Top of dam elevation

METHOD USED:

Critical flow at the control section (end of the approach channel) was assumed.

Formula Used: $Q = C_2 \cdot b \cdot H_m^{1.5}$

C_2 = Discharge coefficient from Table 8-7 page 8-58 (Handbook of Hydraulics by King-Brater)

b = bottom width of spillway channel

H_m = energy head

The friction and bend losses in the approach channel were estimated equal to 10 percent of the energy head.

TABLE 5
RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (CFS)	Peak Lake Elevation (ft.-MSL)	Total Storage (AC.-FT.)	Peak Outflow (CFS)	Depth (ft.) Over Top of Dam
-	-	*892.0	82	0	-
0.10	126	892.6	89	12	-
0.15	189	892.9	93	18	-
0.20	252	893.2	96	28	-
0.25	315	893.4	98	40	-
0.30	378	893.7	101	51	-
0.35	441	893.9	104	63	-
0.37	466	**894.0	105	67	0
0.40	504	894.1	107	83	0.1
0.50	630	894.4	110	208	0.4
1.00	1260	894.9	116	948	0.9

The percentage of the PMF that will reach the top of the dam is 37 percent.

*Primary spillway crest elevation

**Top of dam elevation

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9
HYDROGRAPH AT	1	0.07	1	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.50	1.00
	(0.18)	(3.57)	(126.	189.	252.	315.	378.	441.	504.	567.	630.	1260.
ROUTED TO	2	0.07	1	0.35	0.52	0.80	1.12	1.45	1.78	2.35	5.89	26.83
	(0.18)	(0.35)	(12.	18.	28.	40.	51.	63.	83.	208.	948.	26.83

SUMMARY OF DAM SAFETY ANALYSIS

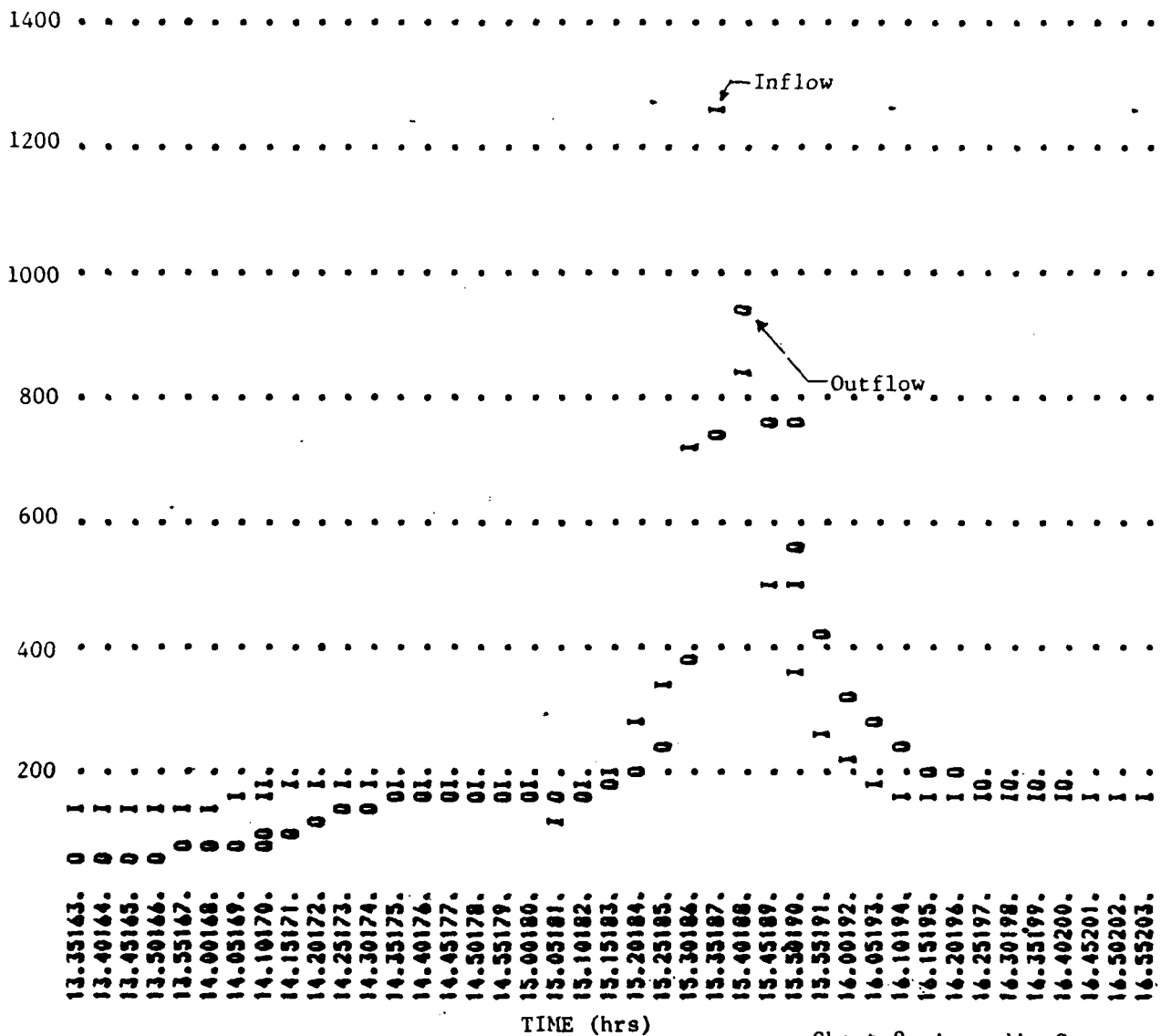
PLAN 1	ELEVATION	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM	DURATION	MAXIMUM	MAXIMUM	MAXIMUM	TIME OF	TIME OF
	STORAGE	892.00	892.00	894.00	HOURS	OUTFLOW	STORAGE	DEPTH	MAX OUTFLOW	FAILURE
	OUTFLOW	82.	82.	105.		CFS	AC-FT	OVER DAM	HOURS	HOURS
		0.	0.	67.						
RATIO	MAXIMUM	MAXIMUM	MAXIMUM	MAXIMUM	MAXIMUM	MAXIMUM	MAXIMUM	MAXIMUM	MAXIMUM	MAXIMUM
OF	RESERVOIR	DEPTH	STORAGE	OUTFLOW	DURATION	OUTFLOW	STORAGE	DEPTH	MAX OUTFLOW	FAILURE
PMF	U.S.ELEV	OVER DAM	AC-FT	CFS	HOURS	CFS	AC-FT	OVER DAM	HOURS	HOURS
0.10	892.61	0.00	89.	12.	0.00	12.	89.	0.00	18.00	0.00
0.15	892.92	0.00	93.	18.	0.00	18.	93.	0.00	18.00	0.00
0.20	893.18	0.00	96.	28.	0.00	28.	96.	0.00	17.08	0.00
0.25	893.42	0.00	98.	40.	0.00	40.	98.	0.00	17.00	0.00
0.30	893.67	0.00	101.	51.	0.00	51.	101.	0.00	16.17	0.00
0.35	893.91	0.00	104.	63.	0.00	63.	104.	0.00	16.08	0.00
0.40	894.13	0.13	107.	83.	1.92	83.	107.	0.13	16.00	0.00
0.50	894.39	0.39	110.	208.	3.00	208.	110.	0.39	15.83	0.00
1.00	894.90	0.90	116.	948.	5.83	948.	116.	0.90	15.67	0.00

PMF Ratios
 OUTPUT DATA

DISCHARGE (cfs)

INFLOW-OUTFLOW
HYDROGRAPH
FOR THE PMF

Max. Inflow = 1260 cfs
Max. Outflow = 948 cfs

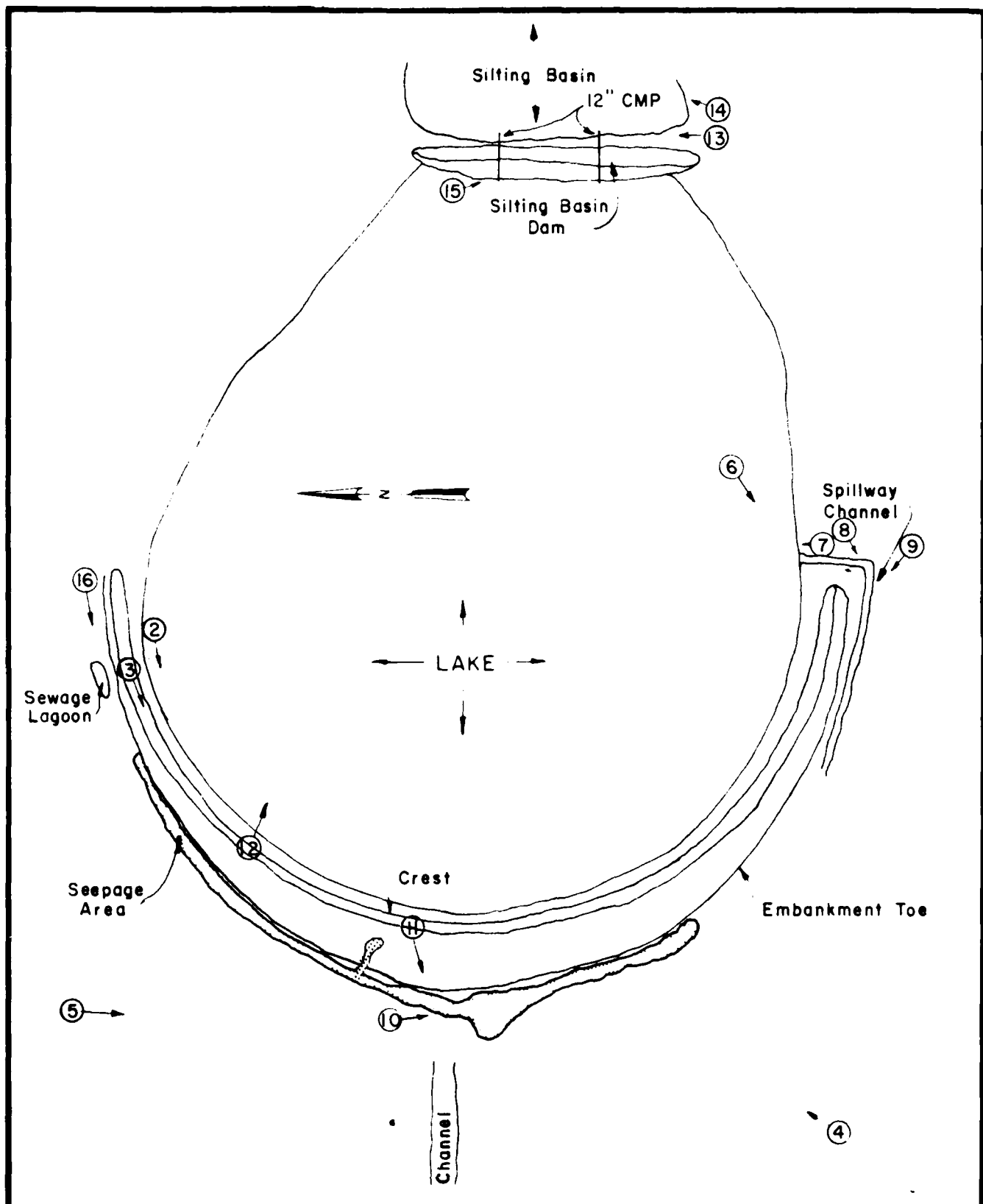


APPENDIX D

Photographs

LIST OF PHOTOGRAPHS

<u>Photo No.</u>	<u>Description</u>
1	Aerial View of Lake and Dam
2	Upstream Face of Dam - Looking from Right Abutment
3	Crest of Dam - Looking from Right Abutment
4	Downstream Face of Dam - Looking from Downstream
5	Downstream Face of Dam
6	View of Approach to Spillway
7	View of Spillway Crest - Looking Upstream
8	Spillway Outlet Channel - Looking Downstream
9	Spillway Outlet Channel Passing Down Embankment Toe
10	Close-Up View of Some Seepage at Downstream Toe
11	View of Downstream Features
12	View of Lake and Watershed Area
13	View of Crest of Silting Basin Dam - Looking Toward Right Abutment
14	View of Silting Basin and Watershed
15	View of Right Silting Basin Outlet Pipe
16	View of Sewage Lagoon near Right Abutment of Dam



Photograph Locations



SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Lake Ja-Ha Dam
Miller County, Missouri
Mo. I.D. No. 30251

Sheet 2, Appendix D

